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Reply To: 3420

Date: July 17, 1995

To: District Ranger, Sierraville RD, Tahoe National Forest

Subject: Entomology input to the Eastside Restoration Project (FPM Report No. NE95-12)

At your request for entomology input to the Eastside Restoration Project (ERP) analysis, Robin Petersen, Biologist, and I conducted field reviews of the ERP areas on July 7, 11, and 12, 1995. The objective of my field reviews were to obtain a better understanding of the ecosystems operating in the ERP analysis areas and also to identify what bark beetles are involved in the current conifer mortality.

Existing Condition

The recent past and current conifer mortality throughout the Sierra Nevada and southern Cascades range is the result of several years of inadequate moisture levels, bark beetle attacks and in some cases, overstocking and the existence of off-site tree species. Over time, tree and shrub densities throughout eastside landscapes have substantially increased. Trees, shrubs, grasses and herbs compete for often limited water, sunlight and nutrients. Increased competition for limited site resources has invited large increases in insect populations. According to the Palmer Drought Index, an index of meteorological drought or moisture excess ranging from -6 to +6, the Sierra Cascade Zone has recorded annual average drought conditions nine times since 1984 (Figure 1). Conifer mortality tends to increase whenever winter precipitation is less than approximately 80% of normal. Trees suffering from inadequate moisture levels have their defense systems weakened to the point that they become more susceptible to attack by bark, engraver and wood boring beetles. Pathogens and/or adverse site or stand conditions predispose trees to successful bark beetle attack.

Bark and engraver beetle-related mortality occurs primarily in small groups with the pine bark beetles or as single trees often scattered over several hundreds of acres with the fir engraver. Successful attacks by the pine bark beetles (western, mountain and Jeffrey pine beetles) result in tree mortality. Successful attacks by the fir engraver (in red and white fir) can result in top-kill, branch kill, patch kills along the bole and/or mortality. In general, mortality occurs in overstocked stands, however during periods of protracted drought, mortality may be expected to occur throughout various stocking regimes. Effects resulting from bark beetles can include the following:

* direct tree mortality
* openings that vary in size

* less trees/acre
* reduced canopy closure
* increase in standing dead and down woody material
* increase in fuel load
* increase in decomposition and nutrient cycling
* increase species diversity/decrease species diversity
* increase in snags and cavity nesting opportunities
* chance in species composition

The following information is based on field surveys. I attempted to map as much of the current and past bark and engraver beetle-related mortality as I could see from the chosen routes (highlighted in yellow) within the ERP areas (see attached quad maps). Based on my observations, conifer species not discussed below are not experiencing above normal levels of bark beetle related mortality. Mapping in some areas does not distinguish between ponderosa and Jeffrey pine. For the purposes of this report I have labeled the two ERP areas as ERP West and ERP East.

White fir: There is extensive old and current white fir mortality in both project areas. Although high levels of mortality occur in some places in ERP West, there are extensive and contiguous areas of extreme mortality in ERP East. White fir dominates many areas on the eastside that were once dominated by pine species. Fire exclusion and selection harvesting practices have caused a continued shift away from shade-intolerant pine species toward more shade tolerant white fir. The significant increase in mortality over the past few years is a result of the severe moisture stress, fir engraver attacks and overstocking of the predominantly off-site white fir.

The fir engraver (Scolytus ventralis) attacks both white and red fir in California. Trees from large saplings to mature are susceptible. Attacks can cause patch-killing of the cambium along the bole, top-kill, branch kill or tree death. Tree survival is quite common when only tops or branches are attacked. Top-kill or death occur most often in firs that have been weakened by root disease, dwarf mistletoe, overstocking, soil compaction, sunscald, logging injury, or drought.

The fir engraver usually completes its life cycle in one year. Adults fly and bore into trees from June to September. Trees colonized early in the summer may begin to fade by early fall, but those colonized later in the year usually do not fade until the following spring or summer, often after the beetles have emerged. The trees that were attacked last year are just beginning to fade. This is later than normal due to the above normal precipitation experienced during 1994-1995 (Figure 1, Jan. 1995 - May 1995). Additional mortality resulting from last year's attacks should be expected throughout this summer.

Red fir: Although red fir exists in both analysis areas the majority of the current drought and fir engraver-related mortality is occurring in the type in ERP East. Cytospora canker and dwarf mistletoe are also contributing to overall tree decline. Additional mortality should be expected throughout this summer as the extreme winter has prolonged tree fade. The red fir in ERP West that I examined (south of Treasure Mtn.) is not experiencing above normal levels of fir engraver-related mortality at this time.

Ponderosa pine: The significant increase in ponderosa pine mortality over the past few years can be attributed to severe moisture stress, overstocking in some cases, and elevated bark beetle activity. Current and older groups kills of ponderosa pine are common in the ERP areas. Mortality of single large DBH ponderosa pine are also common in some areas. The bark beetles associated with the mortality are western pine beetle and mountain pine beetle.

The western pine beetle, Dendroctonus brevicomis, breeds in the main bole of living ponderosa pine larger than about 4 inches DBH. Normally this bark beetle breeds in trees weakened by drought, overstocking, root disease, dwarf mistletoe or fire. Adult beetles emerge and attack trees continuously from spring through fall. Depending on the latitude and elevation, there can be from one to four generations per year. Initial attacks are made about mid-bole and subsequent attacks fill in above and below. Pheromones released during a successful attack attract other western pine beetles. Attacking beetles may spill over onto nearby apparently healthy trees and overwhelm them by sheer numbers. Bluestain fungi introduced during successful attacks contributes to the rapid mortality associated with western pine beetle attacks.

The mountain pine beetle, Dendroctonus ponderosae, attacks the bole of ponderosa, lodgepole, sugar and western white pines larger than about 4 inches DBH. The life cycle of the mountain pine beetle varies considerably over its range. One generation per year is the general rule, with attacks occurring from late June through August. Attacks may extend from the root collar up to near the top. Pheromones released during a successful attack may attract enough beetles to result in a group kill. The sapwood of successfully attacked trees soon becomes heavily bluestained. The bluestain fungi aid in overcoming the defenses of the host tree.

Jeffrey pine: Above normal levels of Jeffrey pine mortality have been observed on the eastside of the Sierra Nevada range since 1990. This mortality is associated with successful attacks of the Jeffrey pine beetle. It appears that the majority of the Jeffrey pine beetle-related mortality within the analysis areas has occurred within the past 2-3 years. Currently, large groups of trees and scattered, large DBH individual trees are beginning to fade as a result of attacks last year. In addition to these fading trees, I observed several trees in close approximation to these group kills that are currently being attacked. These current attacks will result in additional mortality next year which will become noticeable as the trees begin to fade (late this fall or next spring).

The Jeffrey pine beetle, Dendroctonus jeffreyi, is the principle bark beetle found attacking Jeffrey pine, which is its only host. The life cycle is normally completed in one year in the northern part of the range. The principle period of attack is in June and July, but attacks also are frequent in late September and early October. Presence of the beetle is usually detected when the foliage changes color. The color change of the foliage is related to the destruction of the cambium layer by the beetle. Generally, the top of the crown begins to fade in a slow sequence, with the needles turning from greenish yellow, to sorrel, and finally to reddish brown. By the time the tree is reddish brown, the beetles have usually abandoned the tree. Several other organisms are associated with Jeffrey pine beetle attacks. Bluestain fungi, yeasts, and other fungi are transferred into the tree by the attacking adults.

Lodgepole pine: The extended drought conditions have exacerbated the lodgepole pine mortality in ERP West. The majority of this mortality is the result of successful mountain pine beetle attacks and is occurring in stands that have the characteristics of being highly susceptible to mountain pine beetle attack: dominated by trees greater than 8" DBH, greater than 80 years old and occurring in pure or nearly pure lodgepole pockets. Most trees that were attacked last year still have green crowns, however, most observations revealed larva and pupae under the bark, indicating these trees will fade and die this summer.

Pine plantations: During 1993, some pine plantations in ERP West experienced gouty pitch midge damage. I observed 2 of these plantations located south of Cold Creek Campground (730-7 & 730-6). I did not observe extensive pitch midge damage, however, a more extensive survey can be conducted if needed. Adults of the gouty pitch midge, Cecidomyia piniinopis, are small mosquito-like flies. Pitch midge adults emerge from late March through early May and lay eggs on expanding branch and leader tips of the primary host, ponderosa pine. The larvae that hatch from the eggs bore through the surface of the shoot and embed themselves in the vascular tissue. The larvae feed in resin-filled cavities until late winter or early spring when they crawl out of the feeding pits to pupate on the needles.

A few feeding pits on a shoot will have little effect on the tree, but as the number increases, growth and conduction will be affected. If the pits girdle the shoot, it will die. When the pits are distributed on only one side of the twig, the difference in growth rate may cause a twisted branch or leader. The feeding pits cause a canker-like scar which remains visible on the twig for many years. Repeated infestations will reduce the growth rate, cause deformity and predispose the tree to attack by other organisms.

Mortality Outlook (1-2 years)

Experience from the 1975-77 drought indicates that surviving trees can regain their vigor relatively quickly after precipitation and soil moisture levels return to normal. Based on survey data from northern California forests, mortality declined from about 5.5 billion board feet in 1977-78 to about 1.0 billion board feet in 1978-1979. The recent drought lasted much longer and it is likely the surviving trees may take longer to recover than during the 1970's drought period. The new mortality that is currently visible is the result of bark beetle attacks last year, therefore, I would not expect to see any decrease in fading trees or mortality this year. Although bark beetle population levels are difficult to estimate, it can be concluded that there are more bark beetles present now than before the substantial increase in conifer mortality levels, therefore, there will be a abundant supply of beetles emerging this summer and attempting to attack new trees. If the trees are able to immediately use the ample precipitation, some attacks should result in pitch outs (ie. unsuccessful). However, Jeffrey pine beetlea are currently emerging and attacking new trees with few or no resulting pitchouts.

Management Alternatives

The following alternatives are general ones that can be applied to the Eastside Restoration Project. More site specific evaluations may be used to develope management alternatives to meet or at least start in the direction of a desired future condition.

(1) No action - Overstocked stands in general will tend to have higher levels of bark and engraver beetle-related mortality. The recent protracted drought period has brought attention to both the high level of pine and white fir mortality and the existing extreme fire hazard now present in the eastside type. With no management, the areas of extreme mortality present a fire hazard similar to those which resulted in the 1994 Cottonwood fire. The basal areas in stands that were not burned will continue to increase as the trees grow. Periodic droughts in California increase the probability that some of the overstocked stands will be attacked by bark beetles. Although some mortality may be desired for snags, small openings and for future down woody debri, the no action alternative will most likely result in unacceptable levels of mortality below the red fir zones at some point in the future.

(2) Detection Surveys - Forest Pest Management currently provides funding to conduct aerial mortality surveys to obtain better estimates of drought/bark and engraver beetle-related mortality levels. This should facilitate in mapping concentrations of mortality. Based on this information, management priorities can be directed to stands that are highly susceptible to large scale fires and subsequent mortality.

(3) Salvage - Salvage sales can minimize the economic loss and reduce the amount of dead fuel, however these operations will have little or no effect in reducing or controlling bark beetle populations. At the present time, there are no biologically effective or economically efficient methods available to reduce bark beetle populations on an area-wide basis under current California conditions such that tree mortality will be reduced to acceptable levels. As a general rule, during periods of above normal tree stress, it is recommended that logging, thinning and timber stand improvement work be minimized as much as possible to reduce the potential for additional stress. Where such activities must occur, extra care should be taken to prevent damage to residual trees.

(4) Thinning Overstocked Stands - Management activities that promote tree health and vigor also reduce the susceptibility to successful bark beetle attack. There are several natural and regenerated stands that are currently carrying more than the sites can support. Silvicultural prescriptions designed to reduce basal area and select against residual white fir, where it is growing off-site, should result in lower levels of mortality in the future. Some species diversity is desired as bark beetles are fairly host-specific. Diversity should guarantee that some trees will remain alive during elevated stress periods. Removing competing vegetation from plantations will reduce the susceptibility to various insects which often cause damage to regeneration.

(5) Prescribed burning - Fire regimes in the eastside pine type have generally gone from frequent, low severity fires to infrequent, high-severity fires that result in long-term impacts over large, contiguous areas (ie. Cottonwood and Crystal fires of 1994). Due to the excessive fuel loading, it will be difficult to conduct prescribed fires in several areas of the ERP within the near future, without extensive salvage. Burning to maintain the long-term health of stands would be most successful if the process was initiated when the stands are young, and burns are repeated at relatively frequent intervals. Burning is most likely to be compatible with areas that

are managed on an extensive basis, and where individual trees have a lower resource value.

Desired Condition

The desired state of forest health is the condition where biotic and abiotic influences do not threaten resource management objectives and provide desired, sustainable ecosystems. Resource management objectives reflect the many uses and values of the eastside forests including wildlife, recreation, timber, grazing, water and wilderness, and must take into consideration ecological limitations and processes. Dependent upon management objectives, the acceptable level of bark and engraver beetle-related mortality may vary greatly.

The structure and composition of the eastside ecosystems have changed significantly since European settlement in response to both management activities and climatic events such as periodic drought. A decline in forest health has resulted from these changes, indicated by the increased incidence of bark and engraver beetle infestations, widespread potential for high intensity wildfires, loss of habitat diversity and a decrease in the resiliency of these ecosystems. An accelerated effort is needed to restore overall forest health so that future disturbance events such as drought, fire or insect outbreaks, fall within the ability of the various ecosystems to absorb and thereby maintain their biological integrity and diversity.

Forest health restoration activities should take an ecological approach to multiple-use management. Objectives may include:

* Restoring the resilience to natural stresses.
* Decreasing the risk of catastrophic fires.
* Modifying the vegetation to reduce potential damages caused by insects and disease.
* Managing with a sensitivity to lifestyle as well as ecosystem needs.
* Achieving a desired mosaic of vegetation conditions across the landscape.

If you have any questions regarding this report, please contact me at 916-257-2151. One set of quad maps are inclosed with this report and one set are on file in my office. For additional copies I can be reached at the phone number mentioned above. I am available to participate in the I.D. team process, assist with public meetings and/or conduct more site-specific field evaluations.

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cc: John Kennedy, Sierraville RD